(A sampling of)

Knowledge Management Activities at Ames Research Center

NASA KM Team Telecon

February 19, 2002

Overview

Rich Keller (rkeller@arc.nasa.gov)
- ARC KM Research & Development Overview
- Selected systems: ScienceOrganizer, DARWIN, MER Collaborative Information Portal

Charlotte Linde (clinde@arc.nasa.gov)
- Aviation Safety Reporting System, CALLBACK

Helen Stewart (hstewart@arc.nasa.gov)
- Postdoc, CORE, CKG, Acquisitions Process, PRACA, MPRS

Claire Smith (csmith@arc.nasa.gov)
- Knowledge Sharing Forums

Lisa Faithorn (lfaithorn@arc.nasa.gov)
- NASA Astrobiology Institute

Characterization of Knowledge Management Technology R&D

1. *capture*

    a.   knowledge acquisition *

    b.   machine learning

2. *preservation*

    a.   repositories ***

    b.   organizational memory/
           lessons learned/Q&A ***

3. *augmentation*

    a.   knowledge mining *

    b.   knowledge integration **

    c.   metadata

4. *dissemination*

    a.   expertise locator

    b.   portals/newsletters *

    c.   information agents *

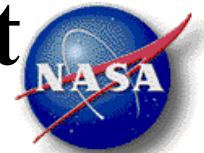   d.   collaboration/meeting/
           communication tools *

5. *infrastructure*

    a.   knowledge modeling/
           knowledge representation *

    b.   ontologies *

    c.   index/search *

    d.   standards *

    e.   networks **

    f.   security *

    g.   access control

Stars indicate amount of R&D activity at ARC

Sampling of Knowledge Management R&D Activities at Ames

- Postdoc (2a) D
- DARWIN (2a) D
- ScienceOrganizer (2a,2b) D
- MER Collaborative Information Portal (4b) P
- Aviation Safety Reporting System (2b) D
- Concept Maps (2b) D
- Complex Object Relationship Engine (2a) P
- MERboard (4d) P
- Aviation Data Integration System (3b) P
- Aviation Passenger Screening & Threat Assessment (3a,3b) C
- Dedal Design Knowledge Capture System (1a) PL
- Program Management Progress Reporting System (2b) D
- International Aviation Data Registry (5b,5d) PL
- Distributed Information Agents for Information Management & Sharing (4c,5c) PL
- Aviation Performance Measuring System (3a) D

- Information Power Grid (5e) D
- IsoWAN (5e,5f) D
- Aviation Extranet (5e) D
- Office of the Future (4d) C
- IMAGEbot (1a,3b) P
- Brahms (5a) D
- WebTagger (2b,5c) P
- Virtual Iron Bird (2a) P
- CALLBACK (5b) D

C: Concept Development
P: Prototype
D: Deployed System
L: Legacy
(Nx): KM technology categories

Some KM Customers/Funders

- **Computing, Information, and Computing Technologies (CICT) Program**
  - Intelligent Systems Program
  - CNIS
- **Engineering for Complex Systems**
- **International Space Station**
- **Aviation Safety Program**
- **Space Shuttle**
- **Mars Exploration Rover Mission**
- **NASA Astrobiology Institute**
- **and others…**

Sampling of Knowledge Management Practice at Ames
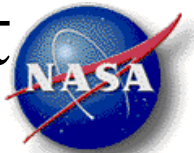
- DARWIN
- Postdoc
- ScienceOrganizer
- Aviation Safety Reporting System
- Concept Maps
- Program Management Progress Reporting System

Technology in Use

Human Systems in Use

- NASA Astrobiology Institute
- Communities of Practice
  - Data mining
  - Collaboration systems
  - Web masters
- Knowledge-Sharing Forums

ScienceDesk Project
Computational Sciences Div.
NASA Ames Research Center

ScienceOrganizer
Information Sharing for Scientific Project Teams

E=MC²
NASA

Contact: Richard Keller, Ph.D.
rkeller@arc.nasa.gov
650.604.3388

- Information-sharing tool for distributed science teams

- Functions as a:
  - document/data/image repository
  - project database
  - "organizational memory" system

Pilot Users:
- ARC Microbial Ecosystems Group
- NAI Ecogenomics Focus Group
- JSC Astrobiology Institute for the Study of Biomarkers
- ARC Electron Microscopy Lab
- ECS Mishap Investigation

- Incorporates intelligent inferencing capabilities to facilitate knowledge entry and maintenance

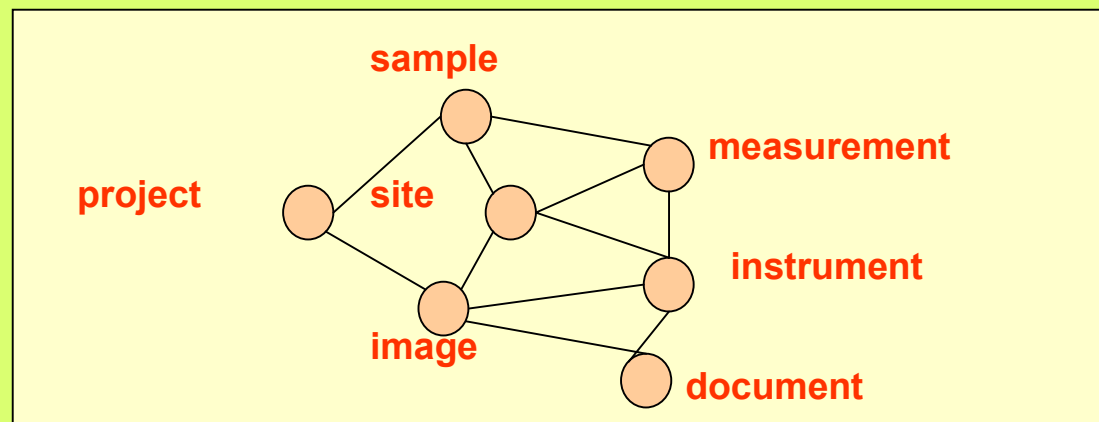- System individually configured to meet distinct needs of each project team

Funders:
- Cross-enterprise Tech Dev Pgm (Thinking Systems thrust)
- Intelligent Systems Program
- NASA Astrobiology Institute

ScienceOrganizer's "Project Information Web"

ScienceOrganizer maintains project information in an interconnected network or "information web"

- Nodes: *information resources (w/metadata)*
- Links: *relationships among resources*

MicrobialCulture-HBC2

Cultivated-by: R. Smith

Genus: phormidium

Growth medium: ASN
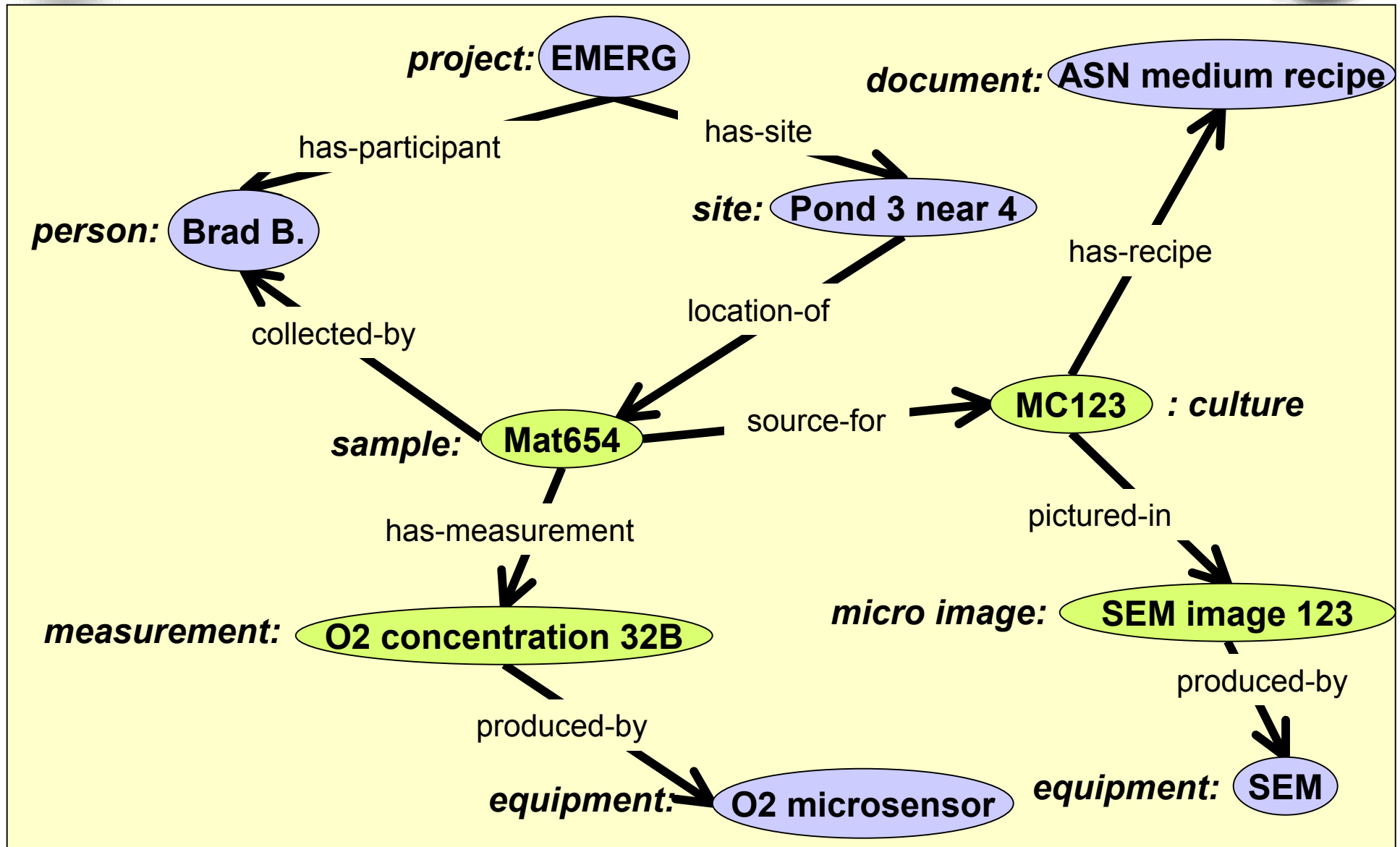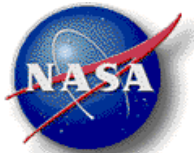
Date isolated: 03-04-00

pictured-in

MicroImage-654

Taken-by: R.Smith

Image date: 1/24/00

Equipment: SEM

Image File:

JPG file

Evolving Web of Project Information

project: **EMERG**

document: **ASN medium recipe**

has-participant

has-site

person: **Brad B.**

site: **Pond 3 near 4**

has-recipe

collected-by

location-of

sample: **Mat654**

source-for

MC123 : culture

has-measurement

pictured-in

measurement: **O2 concentration 32B**

micro image: **SEM image 123**

produced-by

produced-by

equipment: **O2 microsensor**

equipment: **SEM**

Key: "backbone" information   project data

ScienceOrganizer Interface Features
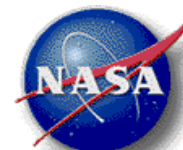
create new records   **search for records**   **create new links**   **icon identifies record type**   **modify records**

Web-based, platform independent access

Links to Related Records

- convenient navigation
- predefined links
- information traceback

click to navigate

Project Information Record

- images
- datasets
- *cultures*
- samples
- field sites
- measurements
- instruments
- lab notes
- publications
- spreadsheets

data fields

DARWIN AeroSpace Data Management

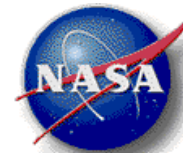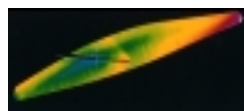22+ CFD & Wind Tunnels Tests - over 1,200,000 points, 150+ variables
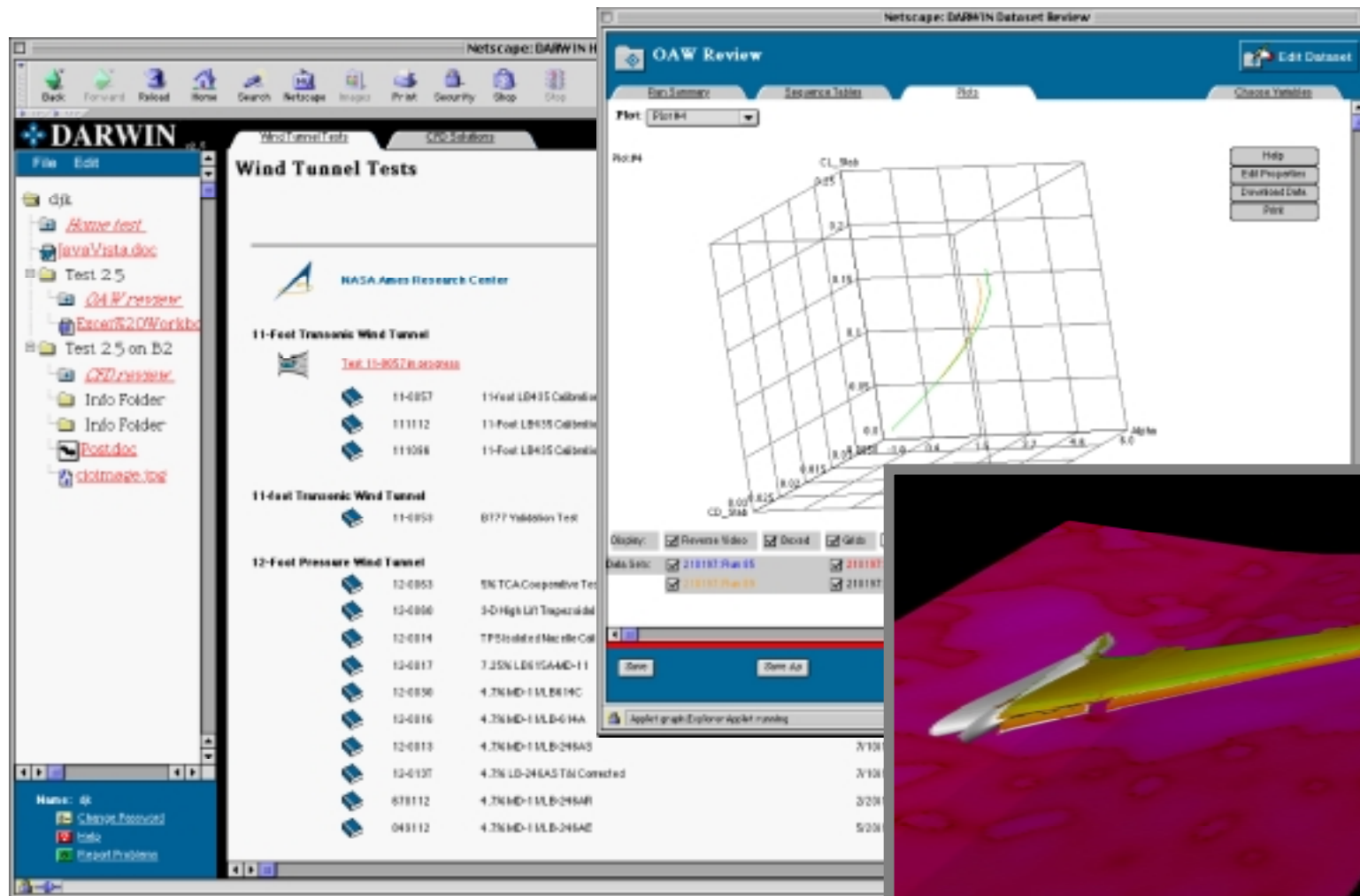
DARWIN Network

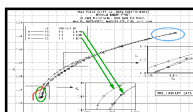**Remote Collaboration via Workstations**

Boeing

Propulsion Test

Lewis

On-line information:

Numerical Results

AST Program

Ames
DARWIN/AEROnet Mgmt.

HSR Program

Experimental Results

Langley

F-16 XL

Facility Databases

Dryden

Boeing

Visualizations
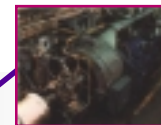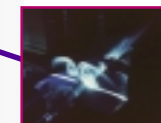
Advantages of DARWIN Technologies:

- Enhanced NASA/Industry collaboration with data security
- Easy industry access to all NASA aeronautics centers
- Faster information delivery and broader utilization
- Integrated knowledge from distributed NASA databases

MER Collaborative Information Portal (CIP)

Concept:

A web-based knowledge management system designed to provide management insight into mission status and operations during MER surface operations. The tool provides dynamic mission information content (from distributed data sources) presented in a user customizable web portal.

The CIP is a "mission enhancement" GDS element. It does not produce or deliver required products for critical path processes and teams.

Software Heritage:

Leveraged Operational Systems:
- **D3 Structured Dist. DMS (from DARWIN ~1997)**
- **CORE Unstructured DMS (from Postdoc ~ 1997)**

COTS Tools, Standard Languages and Interfaces:
- **iPlanet Portal, Oracle V.9 RDBMS, Solaris 8**
- **Java 1.3.1, DHTML, XML, C++, NFS, FTP, etc.**

New Tools (developed in-house):
- **Knowledge Capture, Knowledge Management, and Time-based GUI Development**

Process:

CIP is developed in compliance with a Class-B Software Development Plan conforming to JPL Software Process Development Description (JPL D-15378, Rev. D)
- **Coding Standards (Sun Java, C++), Version Control (CVS), Bug Reporting/Fixes**
- **Requirements/Specifications Documents, User Guides, Training and Test Plans**
- **Design and Delivery Reviews with Doc.**
- **Delivery to GDS via CM Process**

POCs: John Schreiner (jschreiner@mail.arc.nasa.gov)
Joan Walton (jdwalton@mail.arc.nasa.gov)

Sample Interface:

Mission Information Portal Concept
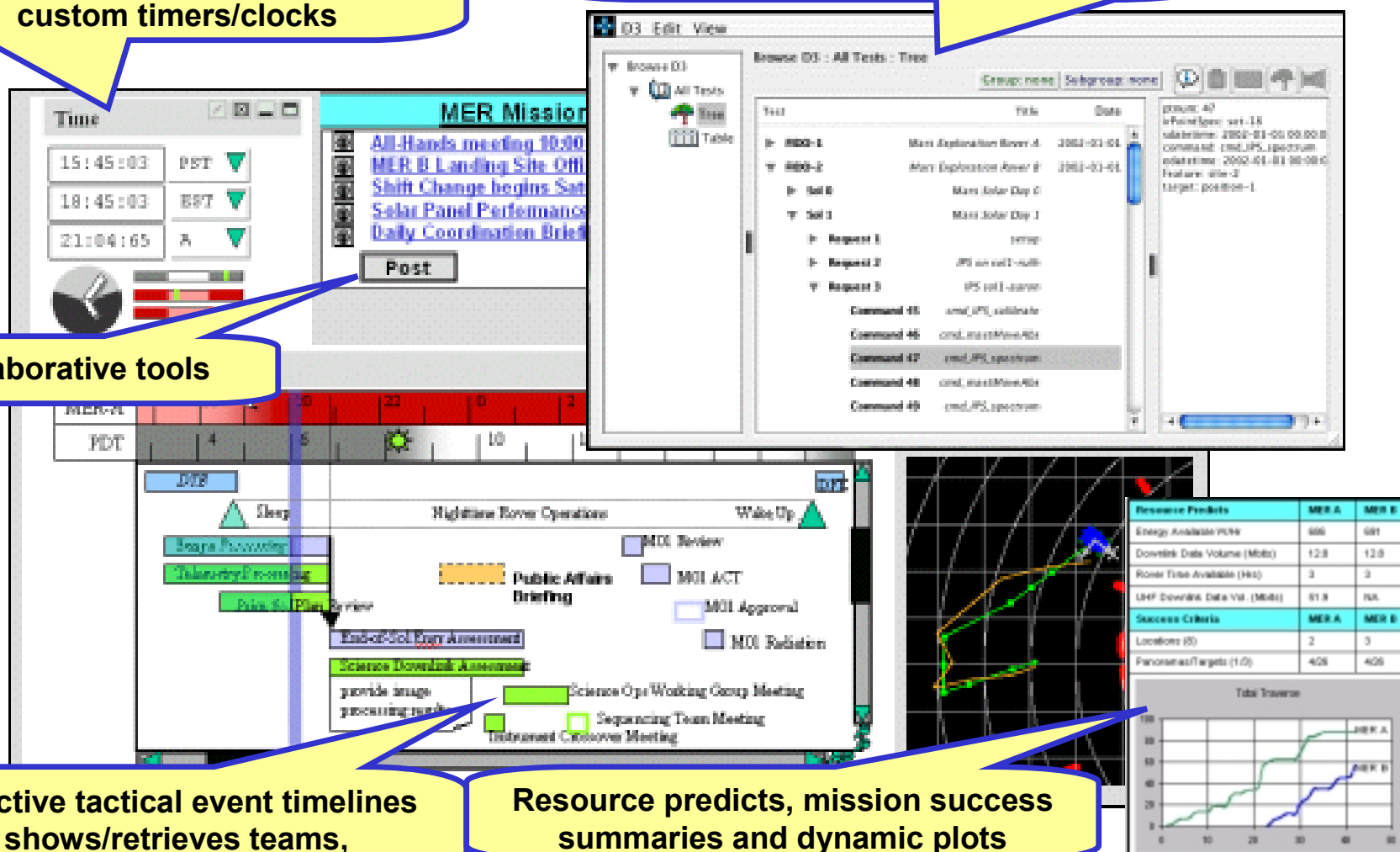
Charlotte Linde
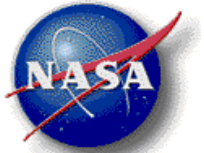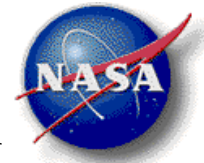
ASRS:
A Successful, Labor-Intensive Lessons Learned System

Aviation Safety and Reporting System

Purpose: collect, analyze, and respond to voluntarily submitted aviation   safety incident reports, to lessen the likelihood of aviation accidents.

• Identify deficiencies and discrepancies in the National Aviation System (NAS) for remedy by appropriate authorities.
• Support policy formulation and improvements to the NAS.
• Strengthen the foundation of aviation human factors safety research.

• **Activities**
  • Aviation personnel submit reports to the ASRS of incidents or situations in which aviation safety was compromised
  • Incentives:
    • Reports are strictly confidential
    • Submission of a report indemnifies reporter against prosecution for unintentional violations of federal aviation statutes
  • Reports are analyzed by experienced pilots and air traffic controllers
• **Product**
  • Communications: FAA alerts, newsletters for pilots and aviation industry
  • Searchable database
  • Human factors research

CALLBACK: A Successful, Labor-Intensive Lessons Learned Communication Effort
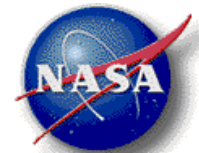
Widely read newsletter reporting news on aviation safety to the aviation community

- Based on reports to ASRS

- Full-time editor (who is a pilot) selects well-written reports on important or unusual topics., and provides introductory framing

  - High level of effort required for capture and production: work of ASRS analysts as well as editor, and writers of reports

  - Low level of effort required from users: CALLBACK is mailed to subscribers, sent to aviation organizations for distribution, and sent to all Aviation Medical Examiners for display in their offices

    - Also available on-line, but paper version has more readers

- Considerable effort paid to creating a readable, folksy voice and genre

- Exact opposite of the promise of automatic, self-documenting lessons learned systems

Helen Stewart

Postdoc

A NASA developed document management system:
40+ NASA Programs, 4262+ Active Users, 61,469+ Items
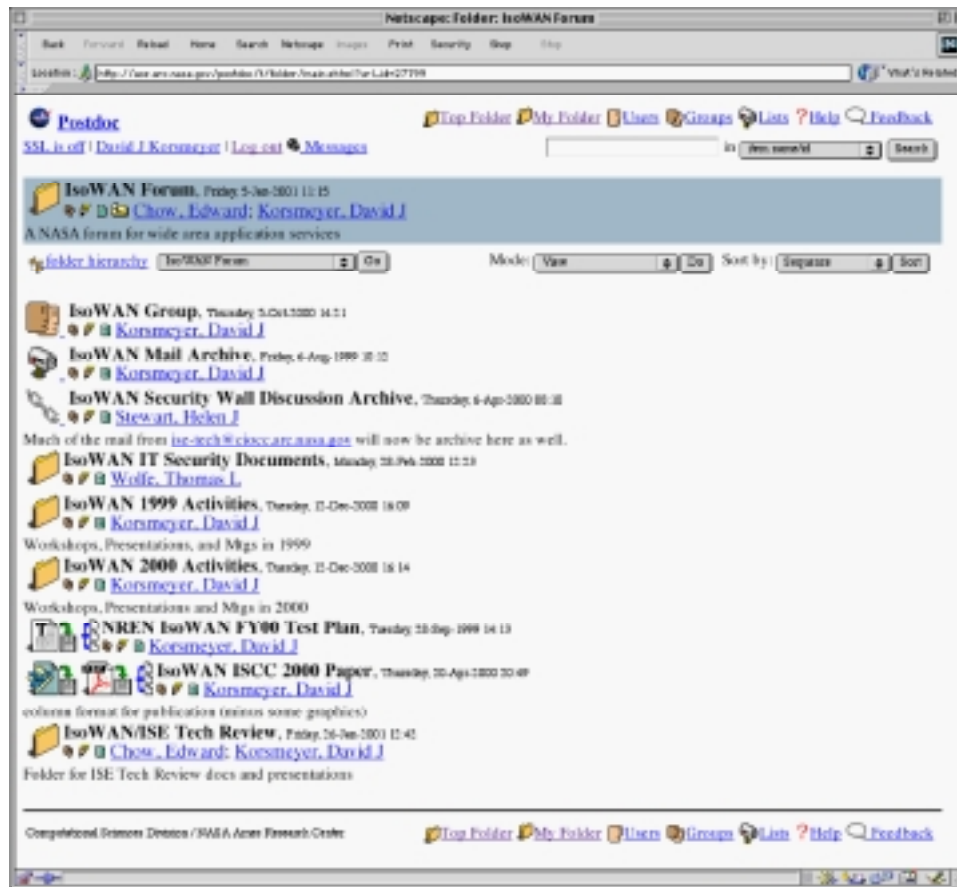
User-definable Project, Group structure

Rapid document sharing

- User-controlled organization and content
- Automatic translation to cross-platform format (PDF, PS)
- Document-level read/write access control by user/group
- Revision tracking and Archiving

Other features

- Action item management, mailing lists, E-mail archiving
- Multiple "views" into data via "template" mechanism

Modular, extensible architecture

- Easily applicable to administrative, legacy, and science data

Complex Object Relationship Engine

In support of Knowledge Management this Research and Development provides next-generation, multi-application object environment for collaboration:

- A common database architecture to support multiple applications and user-interfaces.
- Transparent, two-phase commit transaction management.
- Safe in multi-thread/process/system environments.
- Data stored in programming language neutral form.
- Relational database back-end for scalability and performance.
- Loosely-coupled, abstracted, "plug-in" components.
- Multiple client languages/platforms: Java, JPython, Python. C++ in the works (other ports also possible.)

- Secured sandbox user application space – applications manage but do not enforce access control or authentication functions.
- Access control architecture is:
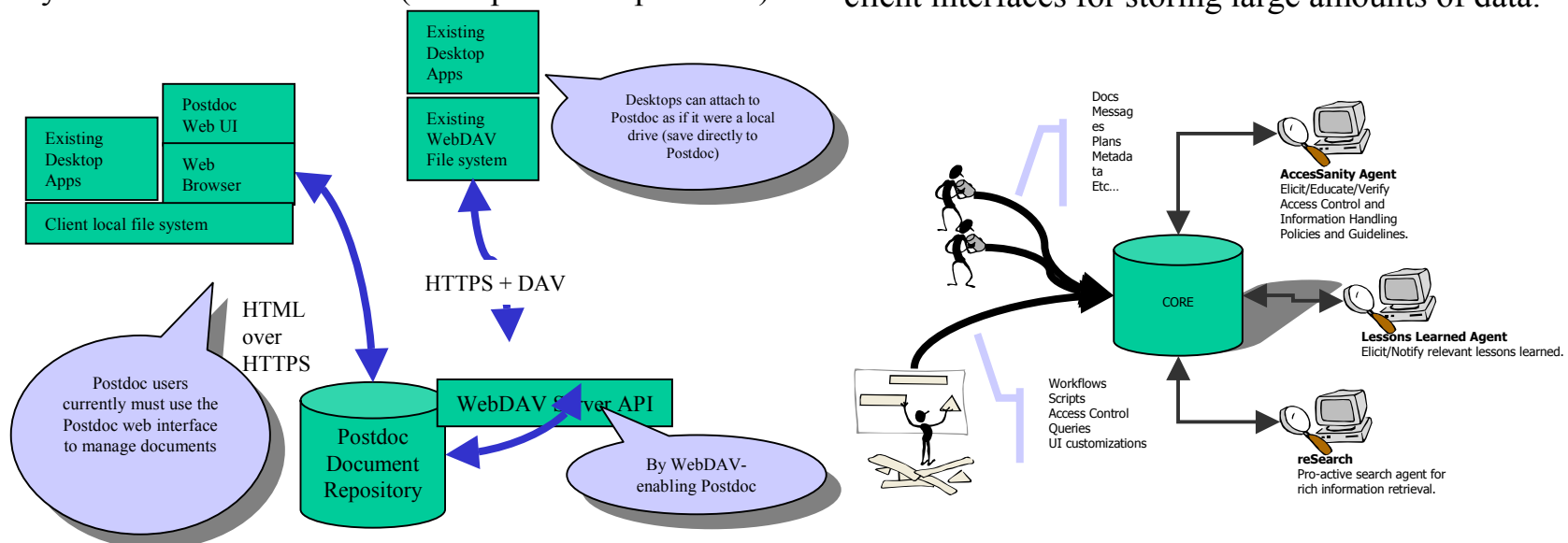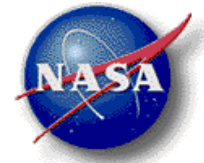 - simple and easy to manage
  - extensible
  - open-standard compliant (WebDAV ACL standard compliant)
  - hierarchical granularity (down to individual data elements)
  - supports any external authentication architecture
- Integrated and protected "file" objects with file-like client interfaces for storing large amounts of data.

Existing Desktop Apps

Postdoc Web UI

Existing Desktop Apps

Web Browser

Client local file system

Existing WebDAV File system

Desktops can attach to Postdoc as if it were a local drive (save directly to Postdoc)

HTTPS + DAV

HTML over HTTPS

Postdoc users currently must use the Postdoc web interface to manage documents

Postdoc Document Repository

WebDAV Server API

By WebDAV-enabling Postdoc

Docs Messages Plans Metadata Etc...

CORE

Workflows Scripts Access Control Queries UI customizations

AcceSanity Agent
Elicit/Educate/Verify Access Control and Information Handling Policies and Guidelines.

Lessons Learned Agent
Elicit/Notify relevant lessons learned.

reSearch
Pro-active search agent for rich information retrieval.

Collaborative Knowledge Grid (CKG)

- **Goal:** Develop a virtual infrastructure capable of providing consistent levels of security across organizational boundaries to enable distributed mission knowledge management, design and development.

- Approach:
    - Revise and refine IsoWAN architecture per customer requirements, ISE engineering review, Trust Group recommendations, and FYO1 testbed lessons learned.
    - Partner with customers' selected projects to prototype and demonstrate Fire Cloud feasibility for mission development.
    - Work with center/agency network & IT security staff to validate and prototype mechanisms for maintaining levels of security across organizational boundaries.

- Major FY'02 Objectives:
    - Revised architecture plan w/ external & customer review
    - Deploy beta test of user applications for two selected projects. FYO3 Operational ECS-DS
    - Cross authenticate w/ NASA Grid to allow CKG access to high-end computational resources
    - Build system capable of providing consistent security up to BRT (Business and Restricted Technology) level

- Customers:
    - Digital Shuttle Project (Code M and ECS program)
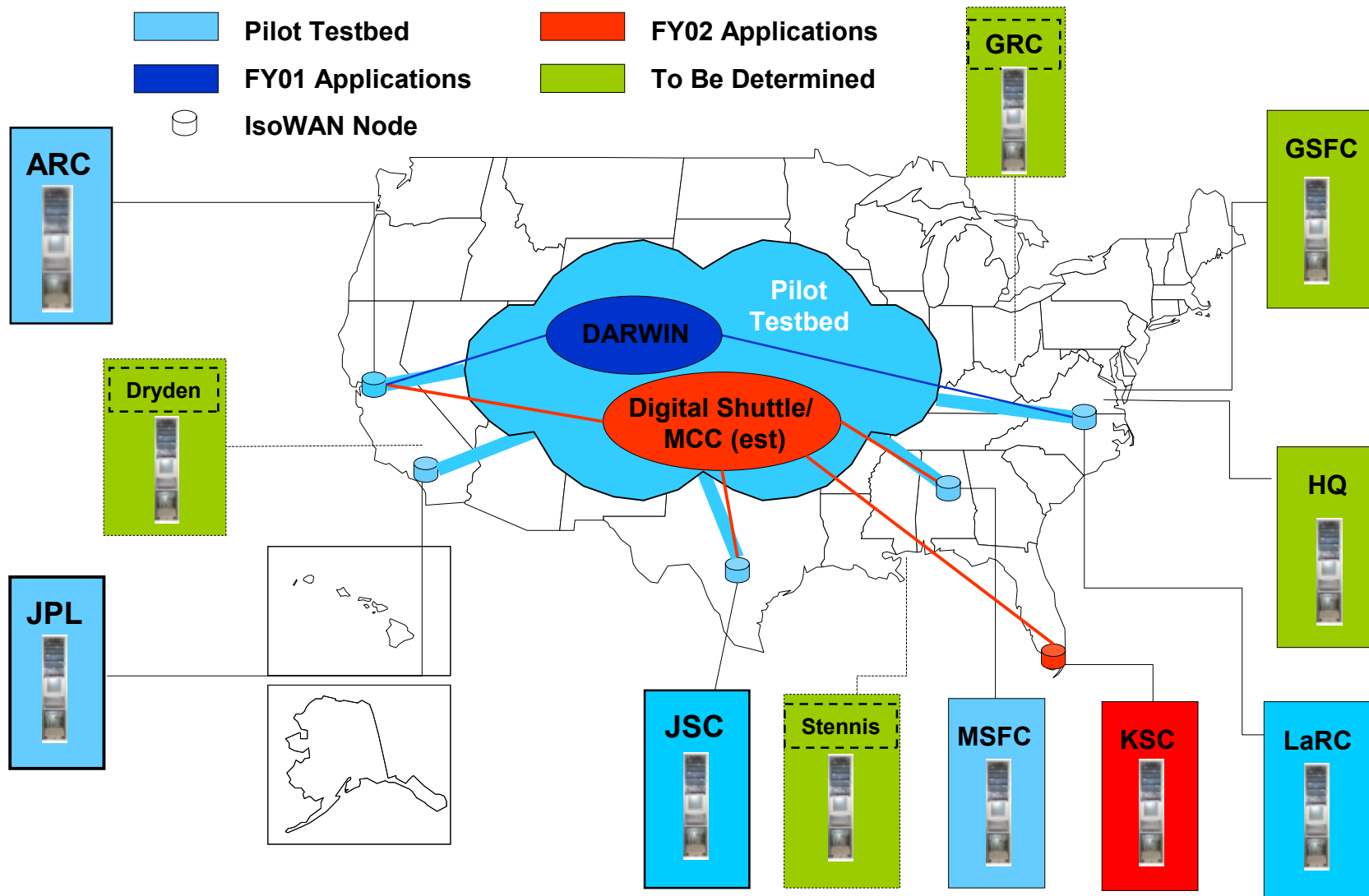   - Mission Control Center Enterprise Model, Strategic Development Office
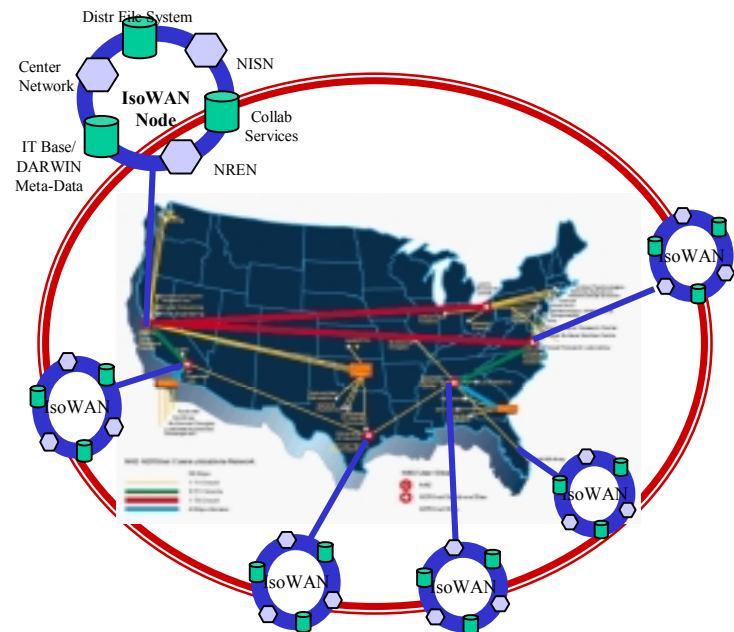
Interconnected IsoNodes supporting NASA-wide services

JPL, ARC, MFSC, LARC, JSC, KSC for Digital Shuttle FY02
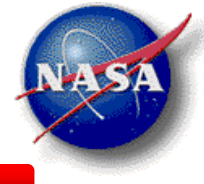
CKG Testbed and Application Partners

Pilot Testbed
FY01 Applications
IsoWAN Node
FY02 Applications
To Be Determined

ARC

GRC

GSFC

Dryden

Pilot Testbed

DARWIN

Digital Shuttle/
MCC (est)

HQ

JPL

JSC

Stennis

MSFC

KSC

LaRC

CKG Conceptual ECS-DS Architecture

- Based on to-date discussions with Digital Shuttle, NASA Grid, and ARC network/VPN/security organizations.

- Provides access to Grid computational resources for distributed mission design and development applications.

- Working with ARC network/IT security to validate and prototype cross organizational boundary security mechanisms.

- Currently working with NASA Grid to develop gateway.

- Opportunity to seed research center technologies into mission development and support communities.
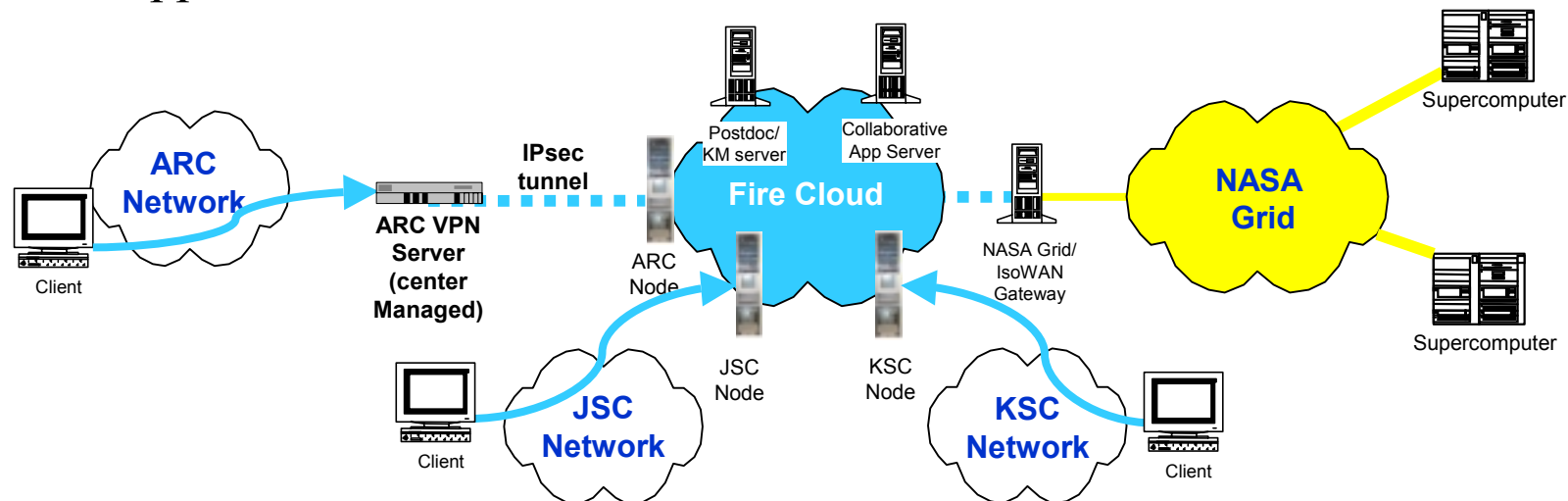
JSC and KSC Client connection specifics will be determined based on center security policies/practices and results of ARC protoyping activities.

Program Management Progress Reporting System
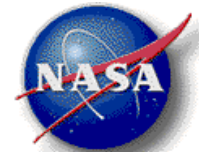
The program management reporting system is a rapid, proof-of-concept prototype tailored to assist program and project managers within NASA enterprises in monitoring, disseminating, and tracking the progress of program and project milestones and other relevant resources.

Consists of an integrated knowledge repository built upon advanced enterprise database integration techniques and the latest web-enabled technologies developed Aerospace Extranet (AEN) InfoLab of the Computational Sciences Division (Code IC) at Ames.

The current system is in a pilot operational mode allowing users to automatically create, generate, update, and view customizable milestone definitions via a secure password protected web site. NASA programs are using the system to automate and track monthly status reports, whereas divisions are utilizing the system for their weekly activity reporting process. The system provides a dynamic view of both program and project milestones, their respective due dates and associated program element levels. The system also provides the capability to perform both context and content-based keyword search on the submitted reports using its unique search engine.
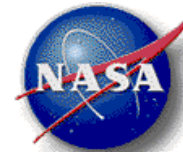
Computational Sciences Division, ARC

Technical POC: David Maluf, Ph.D.   Maluf@ptolemy.arc.nasa.gov
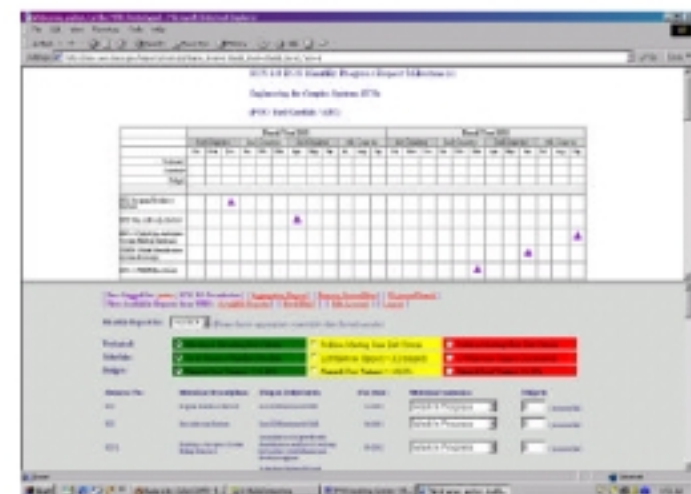
The Acquisition Process as a Vehicle for Enabling Knowledge Management in the Life-Cycle of Complex Federal Systems

This project is research and implementation of effective knowledge management requirements within the federal acquisition process to reduce the likelihood of degradation or failure of critical complex national systems. This is and element of the Lifecycle Knowledge Management for the Digital Shuttle Project supporting the SSP SFOC contract and Engineering for Complex Systems Program.

Objectives: Implement the right contract clauses for 'System KM' in Shuttle Program Space Flight Operations Contract in support of the Lifecycle Knowledge Management for the Digital Shuttle Project of the Engineering for Complex Systems Program.

- Definition of Knowledge Management needs to agreed upon between Contractor and Govt.
  - ✓ Current State Assessment, problem statement, how to statements, what NASA wants statements
- Concurrence on the requirements for System KM
- Negotiation with JSC SFOC and Contracting Officer
  - ✓ Agreement on requirements of Space Flight Operations Knowledge Management

Currently contracts state data rights, but we are additionally requesting information and knowledge rights, we also need better organization of the data/info/knowledge and insurance on it's use and maintenance...

Determination of where should the Knowledge Management clauses reside? SOW or standard statements in the RFPs and contracts. Work with HQ Acquisitions, JSC Acquisitions and CIO for implementation and potential standard and policy.
  - ✓ Develop a MOA with CIO, Code M Policy and Planning, and Procurement

Technical POC: Helen Stewart hstewart@mail.arc.nasa.gov

Managing Lessons Learned for Problem Reporting and Corrective Action Systems

This project jointly undertaken by the Navy Center for Applied Research in Artificial Intelligence (NCARAI), Naval Research Laboratory, Washington, DC, and the Complex Object Relational Engine Project of Computational Sciences Division, Design for Safety Program at the NASA Ames Research Center, Moffet Field, CA. FY00

Goal: *Improve lesson collection by enabling geographically dispersed users to collaboratively author, refer, review, publish, and maintain high-quality reusable lessons.*

The LMTS Lesson Editor (LE) is to enable organizations to document their problem-solving and decision making experiences in a structured format called lessons. These lessons can be retrieved and applied for decision-making in the future. As part of the LMTS project, the LE could be implemented at NASA-ARC. Given the knowledge intensive and the dynamic nature of projects and missions at NASA and its partner organizations, reuse of valuable learned experience is expected to improve the collaboration and the decision-making effectiveness of end users at NASA.

Technical POC: *Helen Stewart.*   *helen@ptolemy.arc.nasa.gov*

Claire Smith
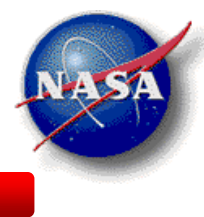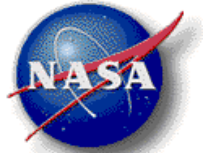
Knowledge Sharing Activity

Vision:

Create opportunities
for capturing and sharing
experienced-based (tacit) knowledge
within and between centers

Knowledge Sharing Activities
2000-Present

- **Forums for Experienced P-pMs**
  - » **Master Project Managers Forum (National & Regional)**
  - » **Center-based Forums (APPL sponsored and Center-led).**

- **Knowledge Transfer Forums (for emerging project leaders)**
  - » **Center-based**
  - » **Ames seen as a "model*"**

    High level of participation in Forums and center-events. Present regularly at forums and in ASK magazine.

- **On-Line ASK* Magazine**

  * "Academy Sharing Knowledge"

Progress To Date

- **Creation, Presentations and Collection of**
  - » **Case Studies**
  - » **"Success Stories"**
  - » **Best Practices**

- **Integration of the KS Forum with NASA's APPL ASK Magazine**

- **Developing pool of mentors, instructors and facilitators for Academy and Center-based activities.**

For More Information

- Contact Claire Smith

  » csmith@mail.arc.nasa.gov

  » [650] 604-0553

- Visit & Read ASK Magazine:

  » http://appl.nasa.gov/knowledge/ask_home.htm

Lisa Faithorn

Astrobiology's Theme Questions
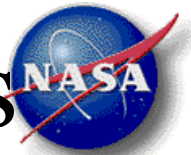
– How does life begin
and evolve?

– Is there life elsewhere
in the universe?

– What is the future for life
on Earth and beyond?

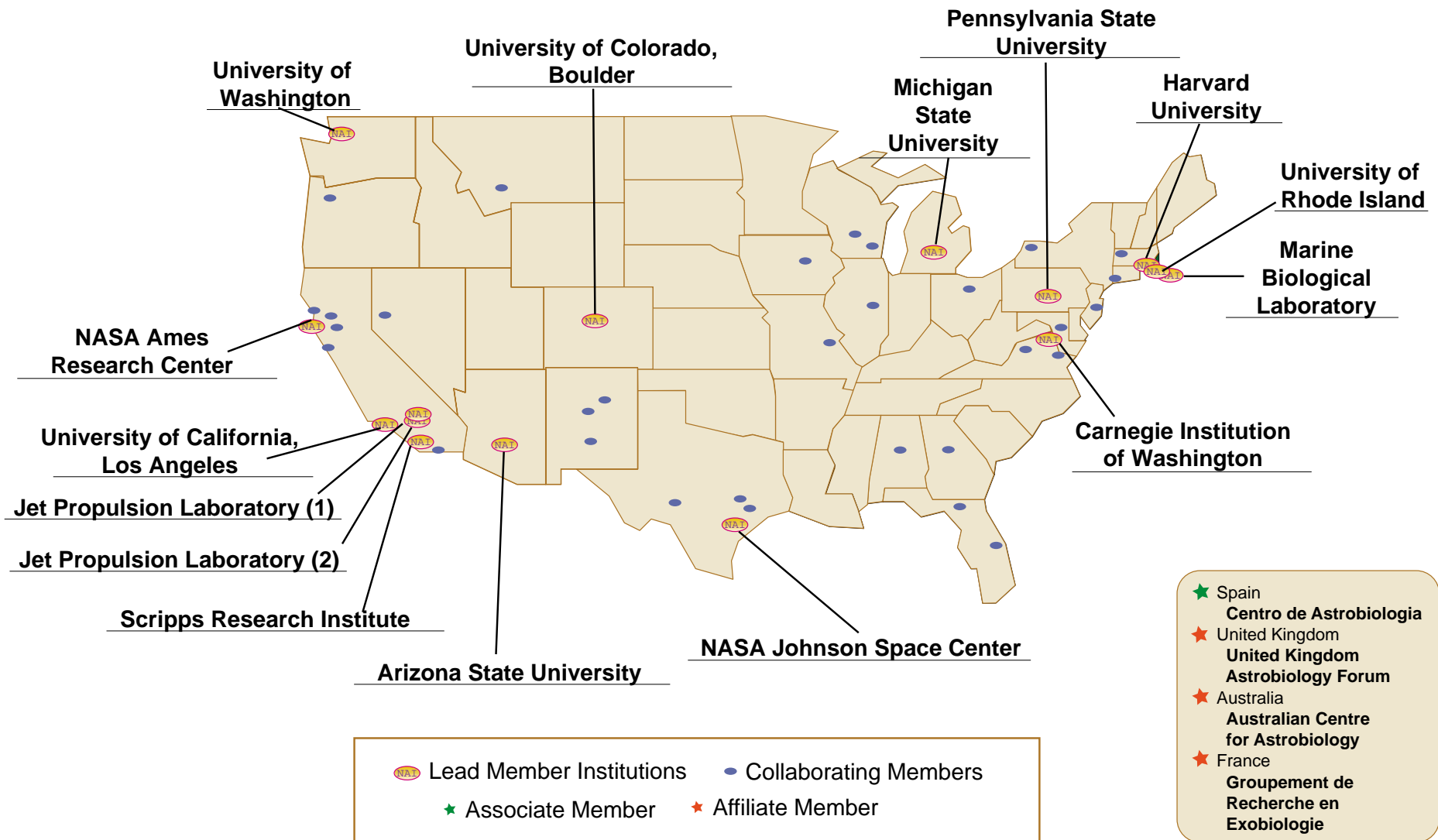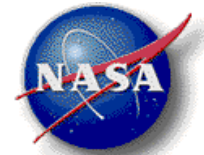# Building a Virtual Community Based on Shared Knowledge

- NAI facilitates interdisciplinary and collaborative research amongst widely-distributed investigators
- NAI supports building a shared knowledge base

NAI Teams

University of Washington

University of Colorado, Boulder

Pennsylvania State University

Michigan State University

Harvard University

University of Rhode Island

Marine Biological Laboratory

NASA Ames Research Center

Carnegie Institution of Washington

University of California, Los Angeles

Jet Propulsion Laboratory (1)

Jet Propulsion Laboratory (2)

Scripps Research Institute

Arizona State University

NASA Johnson Space Center

Legend:
- (NAI) Lead Member Institutions
- • Collaborating Members
- ★ Associate Member
- ★ Affiliate Member

★ Spain
   Centro de Astrobiologia
★ United Kingdom
   United Kingdom Astrobiology Forum
★ Australia
   Australian Centre for Astrobiology
★ France
   Groupement de Recherche en Exobiologie

Updated 1/14/02

NAI Team Science Projects

Number of Projects Addressing this Objective

1. Sources of Organics on Earth
2. Origin of Life's Cellular Components
3. Models for Life
4. Genomic Clues to Evolution
5. Linking Planetary & Biological Evolution
6. Microbial Ecology
7. Extremes of Life
8. Past & Present Life on Mars
9. Life's Precursors & Habitats
10. Natural Migration of Life
11. Origin of Habitable Planets
12. Effects of Climate & Geology on Habitability
13. Extrasolar Biomarkers
14. Ecosystem Response to Rapid Environmental Change
15. Earth's Future Habitability
16. Bringing Life with us Beyond Earth
17. Planetary Protection
18. Currently does not fit into Categories
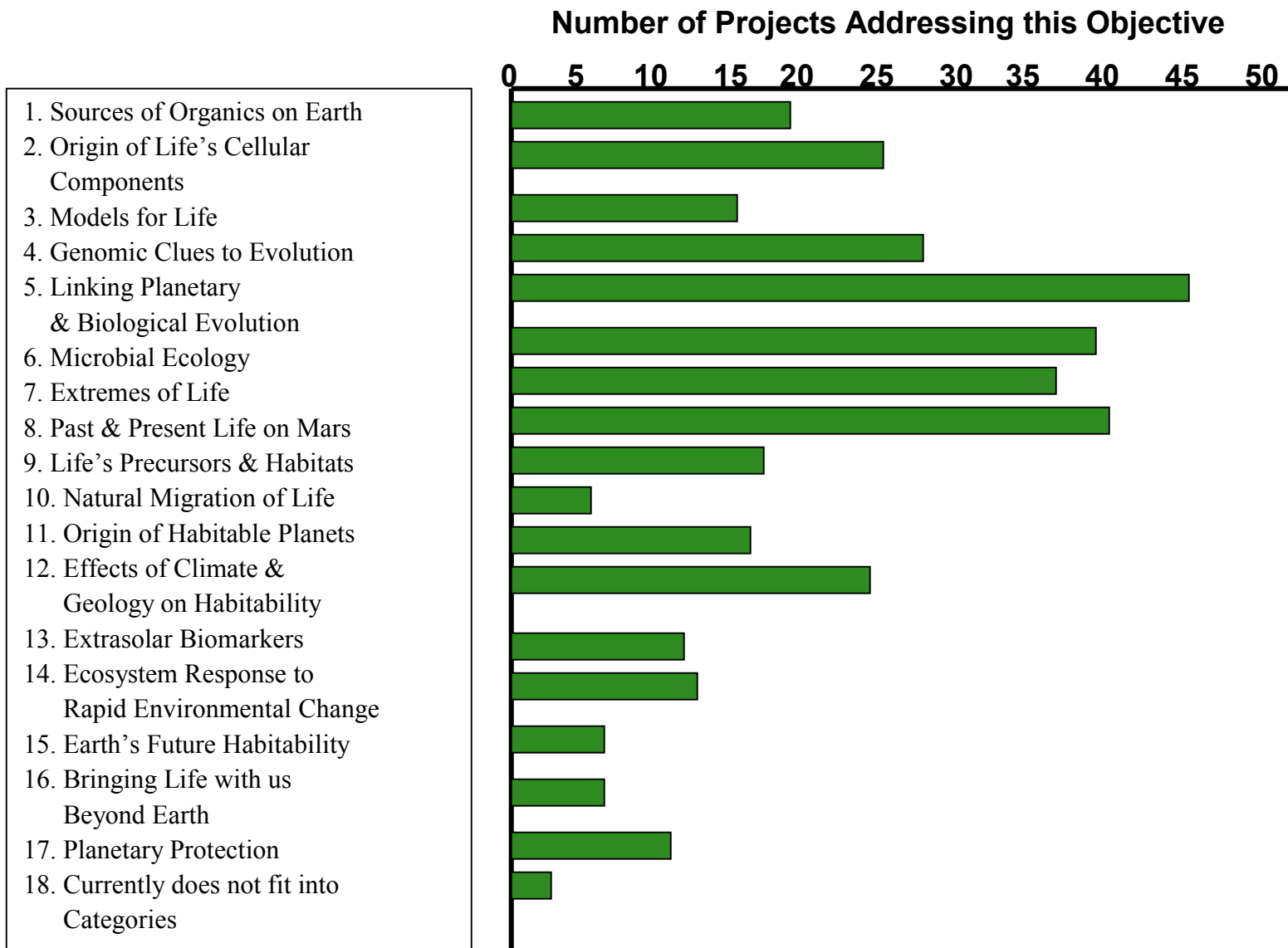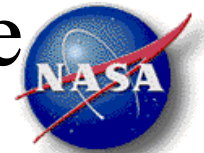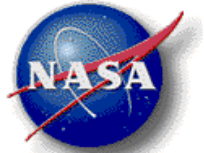
Knowledge Sharing Approach

- Build relationships/develop community
- Research member needs/perspectives
- Identify leading-edge theories and tools/technologies
- Select and deploy tools/technologies
- Provide training and support
- Measure outcomes/evaluate success
- Identify/implement improvements

Build Community: Facilitate Productive Interactions

- **Executive Council - virtual and face-to-face**
- **Point-to-Point meetings - virtual**
- **Focus Groups - virtual and face-to-face**
- **Seminars - virtual and face-to-face**
- **International collaboration - virtual and face-to-face**
- **Education/Public Outreach Group - virtual and face-to-face**
- **IT Working Group - virtual and face-to-face**
- **Postdoctoral Fellowships**
- **Joint workshops**
- **Special sessions and professional meetings**
- **Site visits**
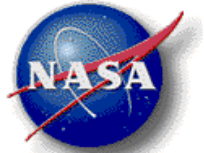- **Outreach activities - products and events**

Identify Key Features of Virtual Institute
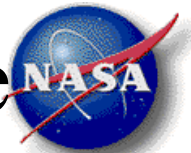
- Specific participant attitudes and behaviors
- Specialized tools and technologies facilitating communication, collaboration and knowledge management
- Regular sharing of data and information
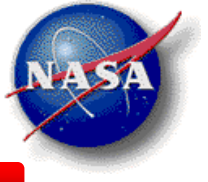- Local institutional and staff support

Identify Major Research Components

- Laboratory Experimentation
- Field-Based Research
- Computational Modeling
- Visualization/Imaging/3-D Modeling
- Remote sensing
- Graphics
- Instrument Development
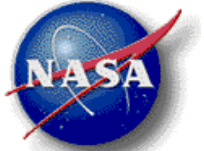- NASA Mission Orientation
- Theory

Identify Kinds of Data/information Sharing

- Text Documents

- Images

- Instrument Data Files

- Models

- Large data sets

- Video Content

- Supercomputer Models

Research Requirements for Tools/Technologies

- Easy to use
- High-speed
- Easily accessible
- Reliable
- Cross-platform
- Secure
- Private
- Web-based
- Cutting-edge
- Reasonable cost

Current Projects

- Development of NIMS Database
- Piloting of Desktop Videoconferencing/Data Sharing Collaboration Tools
- Piloting of ScienceOrganizer
- Comparative Research on Commercially Available Knowledge Management Tools